CLAIMS

1. A method of manufacturing an anode composition for use in a rechargeable electrochemical cell, wherein the anode comprises an electrochemically active material, the method comprising the steps of mixing said material with an alkaline electrolyte solution, an organic surfactant, an indium compound, and a gelling agent, such that said indium compound is mixed in an alkaline environment.

2. The method of claim 1, wherein said indium compound is comprised of a first and second indium compound.

3. The method of claim 2, wherein said active material comprises metallic zinc or a zinc alloy.

4. The method of claim 3, wherein said material is selected from the group consisting of mercury-free and lead-free zinc-bismuth alloy, zinc-lead alloy, zinc-aluminum-bismuth-indium alloy, zinc-calcium-bismuth-indium alloy, and zinc-magnesium-bismuth alloy, and any combination thereof.

5. The method of claim 4, wherein said zinc alloy is selected from the form consisting of particles, powder, particulate, flakes, granulate and any combination thereof.

6. The method of claim 5, wherein said zinc alloy material comprises at least up to 800 ppm lead, up to 800 ppm indium, up to 500 ppm calcium, up to 500 ppm magnesium, up to 200 ppm bismuth and up to 200 ppm aluminum.

7. The method of claim 6, wherein said zinc alloy comprises particles having a particle size distribution of +60 mesh in a range of from about 10% to about 25%, +100 mesh in a range of from about 20% to about 35%, +140 mesh in a range of about 15% to about 25%, +325 mesh in a range of from about 4% to about 20%, and –325 mesh in a range of from about 0% to about 20%.

8. The method of claim 1wherein said indium compound is selected from the group consisting of indium sulfate solution or powder, indium oxide powder, indium hydroxide powder, indium acetate solution or powder and any combination thereof.

9. The method of claim 2, wherein said first and second indium compound is selected from the group consisting of indium sulphate solution or powder, indium oxide powder, indium hydroxide powder, indium acetate solution or powder and any combination thereof.

10. The method of claim 8, wherein said first indium compound comprises at least 0.1% indium by weight to weight of zinc.

11. The method of claim 9, wherein said first indium compound comprises at least 0.01% indium by weight to weight of said zinc and said second indium compound comprises at least 0.05% by weight to weight of zinc.

12. The method of claim 2, wherein total indium content is in the range of from about 0.05% to about 0.5% by weight to weight of zinc.

13. The method of claim 1, wherein said organic surfactant is selected from the group consisting of compounds having polyoxypropylene chains, compounds having polyoxyethylene chains, copolymers thereof and any combination thereof.

14. The method of claim 13, wherein said organic surfactant comprises from about 0.1% to about 0.25% by weight of said zinc powder.

15. The method of claim 14, wherein said organic surfactant has a molecular weight in the range of from about 300 to about 1500.

16. The method of claim 15, wherein said organic surfactant is polyoxyethylene glycol having a molecular weight in the range of from about 400 to about 800.

17. The method of claim 1, wherein said electrolyte comprises an aqueous solution of potassium hydroxide having a concentration of from about 5.5 molar to about 12 molar.

18. The method of claim 1, wherein said electrolyte is added in a first and second portion.

19. The method of claim 18, wherein said first portion of said electrolyte is about 100% of the total volume of electrolyte.

20. The method of claim 18, wherein said first portion of said electrolyte is between about 20% and about 60% of total electrolyte volume.

21. The method of claim 20, wherein said first portion of said electrolyte is about 40% of total electrolyte volume.

22. The method of claim 21, wherein said electrolyte further comprises an aqueous solution of potassium zincate having a concentration in the range of from about 0 molar to about 1.5 molar.

23. The method of claim 22, wherein said electrolyte further comprises lithium hydroxide having a concentration in the range of from about 0 molar to about 2 molar.

24. The method of claim 1, wherein said method further comprises mixing said material with a nucleation additive.

25. The method of claim 24, wherein said nucleation additive is selected from the group consisting of magnesium oxide, magnesium hydroxide, calcium oxide, calcium hydroxide, zirconium oxide and any combination thereof.

26. The method of claim 25, wherein said nucleation additive is up to 2.5% by weight of said anode.

27. A rechargeable cell comprising an anode having the composition manufactured according to the method of claim 1; a cathode, an electrolyte; and a separator between said anode and said cathode.

28. A rechargeable cell comprising an anode having the composition manufactured according to the method of claim 2; a cathode, an electrolyte; and a separator between said anode and said cathode.

29. The rechargeable cell of claim 27, wherein said cathode includes a hydrogen recombination catalyst.

30. The rechargeable cell of claim 28, wherein said cathode includes a hydrogen recombination catalyst.

31. A method of manufacturing an anode composition for use in a rechargeable electrochemical cell, wherein the anode comprises an electrochemically active material, the method comprising the steps of:

(a) mixing said material with an organic surfactant;

(b) mixing said material with a first indium compound;

(c) mixing said material with a first portion of an alkaline electrolyte solution;

(d) mixing said material with a second indium compound; and

(e) mixing said material with a second portion of said electrolyte and a gelling agent.

32. The method of claim 31, wherein steps (a) and (b) are performed simultaneously.

33. The method of claim 31, wherein said active material comprises metallic zinc or a zinc alloy.

34. The method of claim 31, wherein said material is selected from the group consisting of mercury-free and lead-free zinc-bismuth alloy, mercury-free and lead-free zinc-bismuth alloy of

finer particle size, zinc-lead alloy, zinc-aluminum-bismuth-indium alloy, zinc-calcium-bismuth-indium alloy, and zinc-magnesium-bismuth alloy, and any combination thereof.

35. The method of claim 34, wherein said zinc alloy is selected from the form consisting of particles, powder, particulate, flakes, granulate and any combination thereof.

36. The method of claim 35, wherein said zinc alloy material comprises at least up to 800 ppm lead, up to 800 ppm indium, up to 500 ppm calcium, up to 500 ppm magnesium, up to 200 ppm bismuth and up to 200 ppm aluminum.

37. The method of claim 36, wherein said zinc alloy comprises particles having a particle size distribution of +60 mesh in a range of from about 10% to about 25%, +100 mesh in a range of from about 20% to about 35%, +140 mesh in a range of about 15% to about 25%, +325 mesh in a range of from about 4% to about 20%, and –325 mesh in a range of from about 0% to about 20%.

38. The method of claim 31, wherein said first and second indium compound is selected from the group consisting of indium sulphate solution or powder, indium oxide powder, indium hydroxide powder, indium acetate solution or powder and any combination thereof.

39. The method of claim 38, wherein said first indium compound comprises at least 0.01% indium by weight to weight of said zinc and said second indium compound comprises at least 0.05% by weight to weight of zinc.

40. The method of claim 31, wherein total indium content is in the range of from about 0.05% to about 0.5% by weight to weight of zinc.

41. The method of claim 31, wherein said organic surfactant is selected from the group consisting of compounds having polyoxypropylene chains, compounds having polyoxyethylene chains, copolymers thereof and any combination thereof.

42. The method of claim 41, wherein said organic surfactant comprises from about 0.1% to about 0.25% by weight of said zinc powder.

43. The method of claim 42, wherein said organic surfactant has a molecular weight in the range of about 300 to about 1500.

44. The method of claim 43, wherein said organic surfactant is polyoxyethylene glycol having a molecular weight in the range of from about 400 to about 800.

45. The method of claim 44, wherein said electrolyte comprises an aqueous solution of potassium hydroxide having a concentration of in the range of from about 5.5 molar to about 12 molar.

46. The method of claim 31, wherein said first portion of said electrolyte is about 100% of the total volume of electrolyte.

47. The method of claim 31, wherein said first portion of said electrolyte is between about 20% and about 60% of total electrolyte volume.

48. The method of claim 47, wherein said first portion of said electrolyte is about 40% of the total electrolyte volume.

49. The method of claim 48, wherein said electrolyte further comprises an aqueous solution of potassium zincate having a concentration in the range of from about 0 molar to about 1.5 molar.

50. The method of claim 49, wherein said electrolyte further comprises an aqueous solution of lithium hydroxide in the range of from about 0 molar to about 2 molar.

51. The method of claim 31, wherein step (e) further comprises the addition of a nucleation additive.

52. The method of claim 31, wherein step (a) is preceded by the addition of a nucleation additive.

53. The method of claim 51, wherein said nucleation additive is selected from the group consisting of magnesium oxide, magnesium hydroxide, calcium oxide, calcium hydroxide, zirconium oxide and any combination thereof.

54. The method of claim 52, wherein said nucleation additive is selected from the group consisting of magnesium oxide, magnesium hydroxide, calcium oxide, calcium hydroxide, zirconium oxide and any combination thereof.

55. The method of claim 53, wherein said nucleation additive is up to 2.5% by weight of said anode.

56. The method of claim 54, wherein said nucleation additive is up to 2.5% by weight of said anode.

57. A rechargeable cell comprising an anode having the composition manufactured according to the method of claim 31; a cathode, an electrolyte; and a separator between said anode and said cathode.

58. The rechargeable cell of claim 57, wherein said cathode includes a hydrogen recombination catalyst.

59. A rechargeable cell that performs at least twenty-five discharge and charge cycles comprising:

a cathode having an electrochemically active powder including an oxide of manganese;

an anode comprising an anode composition, said composition comprising of an electrochemically active zinc alloy, wherein said composition is manufactured by a method comprising the steps of mixing said zinc alloy with an alkaline electrolyte solution, an organic

surfactant, an indium compound, and a gelling agent, such that said indium compound is added in an alkaline environment;

a separator including at least one semipermeable membrane; and

an electrolyte solution in the separator, the cathode and the anode, and filling pores thereof.

60. The rechargeable cell of claim 59, wherein said indium compound is comprised of a first indium compound and a second indium compound.

61. The rechargeable cell of claim 60 wherein said first and second indium compound is selected from the group consisting of indium sulfate solution, indium sulfate powder, indium oxide solution, indium oxide powder, indium hydroxide solution, indium hydroxide powder, indium acetate solution, and indium acetate powder and any combination thereof.

62. The rechargeable cell of claim 60, wherein the indium compound makes up from about 0.05 to about 0.5% by weight of the electrochemically active zinc.

63. The rechargeable cell of claim 59, wherein said anode composition further comprises a nucleation additive selected from the group consisting of magnesium oxide, magnesium hydroxide, calcium oxide, calcium hydroxide, zirconium oxide, or any combination thereof.

64. The rechargeable cell of claim 63, wherein said nucleation additive is present up to 2.5% by weight of the anode.

65. The rechargeable cell of claim 59, wherein said electrochemically active zinc material comprises a metallic zinc or a zinc alloy.

66. The rechargeable cell of claim 59, wherein said organic surfactant is present in the range of from about 0.1% to about 0.25% by weight of said electrochemically active zinc material.

67. The rechargeable cell of claim 59, wherein said alkaline electrolyte comprises an aqueous solution of potassium hydroxide having a concentration of about 5.5 molar to about 12 molar.

68. The rechargeable cell of claim 67, wherein said electrolyte is added in a first and second portion.

69. The rechargeable cell of claim 66, wherein said first portion of said electrolyte is about 100% of total volume of electrolyte.

70. The rechargeable cell of claim 68, wherein said first portion of said electrolyte is between about 20% and about 60% of total electrolyte volume.

71. The rechargeable cell of claim 70, wherein said first portion of said first portion of said electrolyte is about 40% of total volume of said electrolyte.

72. A rechargeable cell that performs at least twenty-five discharge and charge cycles comprising:

a cathode having an electrochemically active powder including an oxide of manganese;

an anode comprising an anode composition, said composition comprising of an electrochemically active zinc material, wherein said composition is manufactured by a method comprising the steps of:

(a) mixing said zinc material with an organic surfactant;

(b) mixing said zinc material with a first indium compound;

(c) mixing said zinc material with a first portion of an alkaline electrolyte;

(d) mixing said zinc material with a second indium compound; and

(e) mixing said zinc material with a second portion of said electrolyte and a gelling agent;

a separator including at least one semipermeable membrane; and

an electrolyte solution in the separator, the cathode and the anode, and filling pores thereof.

73. The rechargeable cell of claim 72, wherein steps (a) and (b) are performed simultaneously.

74. The rechargeable cell of claim 72, wherein said first and second indium compound is selected from the group consisting of indium sulfate solution, indium sulfate powder, indium oxide solution, indium oxide powder, indium hydroxide solution, indium hydroxide powder, indium acetate solution, and indium acetate powder and any combination thereof.

75. The rechargeable cell of claim 74, wherein said first and second indium compound make up from about 0.05% to about 0.5% by weight of the electrochemically active zinc material.

76. The rechargeable cell of claim 72, wherein said anode composition further comprises a nucleation additive selected from the group consisting of magnesium oxide, magnesium hydroxide, calcium oxide, calcium hydroxide, zirconium oxide, or any combination thereof.

77. The rechargeable cell of claim 76, wherein said nucleation additive is present up to 2.5% by weight of the anode.

78. The rechargeable cell of claim 72, wherein said electrochemically active zinc material comprises metallic zinc or a zinc alloy.

79. The rechargeable cell of claim 72, wherein said organic surfactant is present in the range of from about 0.1% to about 0.25% by weight of said electrochemically active zinc material.

80. The rechargeable cell of claim 72, wherein said first and second portion of said alkaline electrolyte comprises an aqueous solution of potassium hydroxide having a concentration of about 5.5 molar to about 12 molar.

81. The rechargeable cell of claim 80, wherein said first portion of said electrolyte is about 100% of total volume electrolyte.

82. The rechargeable cell of claim 81, wherein said first portion of said electrolyte is between about 20% and about 60% of total electrolyte volume.

83. The rechargeable cell of claim 82, wherein said first portion of said electrolyte is about 40% of total volume of said electrolyte.